-DRAFT-

INTERFACE REQUIREMENTS DOCUMENT (IRD)

FOR THE

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE SERIES R (GOES-R) SYSTEM

SPACE SEGMENT (SS)
TO
DATA COLLECTION SYSTEM (DCS)

Document No.
417-SeriesR-IRD-0005

January 10, 2005

GOES-R PROJECT OFFICE
NASA GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

INTERFACE REQUIREMENTS DOCUMENT (IRD)

FOR THE

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE
SERIES R (GOES-R) SYSTEM

———

SPACE SEGMENT (SS)
TO
DATA COLLECTION SYSTEM (DCS)

January 10, 2005

GOES-R PROJECT OFFICE
NASA GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

INTERFACE REQUIREMENTS DOCUMENT (IRD)

FOR THE

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE SERIES R (GOES-R) SYSTEM

SPACE SEGMENT (SS) TO DATA COLLECTION SYSTEM (DCS)

Prepared By: GOES-R Formulation Team

Approved By:

Alexander Krimchansky, NASA GSFC GOES-R System Manager	Date
Paul Richards, NASA GSFC GOES-R Observatory Manager	Date
Sandra Cauffman, NASA GSFC GOES-R Deputy Project Manager	Date
Michael L. Donnelly, NASA GSFC GOES-R Project Manager	Date
Martin Davis, NASA GSFC GOES Program Manager	Date
NOAA	Date

GOES-R PROJECT OFFICE
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

CHANGE RECORD PAGE

DOCUMENT TITLE: IRD for the GOES-R System SS to DCS

DOCUMENT DATE: January 10, 2005

ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Original	8/11/03	All pages affected	Rev. D1 (First Draft) for review.
Draft 2	1/10/2005	All pages affected	Rev D2 (Second Draft) for review

Table of contents

List of Tables

1.0 INTRODUCTION

The Geostationary Operational Satellite System Series R (GOES-R) is an operational mission planned to make observations from geostationary orbit. The GOES-R mission will provide an Advanced Baseline Imager (ABI), Hyperspectral Environmental Suite (HES), Space Environmental In-Situ Suite (SEISS), Solar Imaging Suite (SIS), Geostationary Lightning Mapper (GLM),and auxiliary communications services that are described below. The five GOES-R mission segments interface and function to support the total GOES-R mission and are listed below. The bold titles are items that are covered in this IRD.

- **Space Segment (SS)**
- Ground Located - Command, Control, and Communications Segment (GL-C3S)
- Product Generation and Distribution Segment (PGDS)
- User Interface Segment (UIS)
- Archive and Access Segment (AAS)

As part of the Space Segment (SS), the GOES-R will support several NOAA auxiliary services:

- GOES Rebroadcast Service (GRB)
- Low Rate Information Transmission (LRIT) Service
- Emergency Managers Weather Information Network (EMWIN) Service
- **Data Collection System (DCS)**
- Search and Rescue (SAR) Service

1.1 Purpose

The purpose of this document is to describe and specify the functional and performance interface requirements for the communication links between the GOES-R Space Segment (SS) and the Data Collection System (DCS).

This document it also intended to provide a basis for the subsequent development of a SS-DCS Interface Control Document (ICD).

1.2 Scope

The interfaces addressed in this document support the exchange of data between the SS and the DCS ground segment.

Only those parameters which are necessary to specify the interface requirements will be referenced here; specifications for the satellite transponder will be contained in a satellite performance specification. This IRD therefore:

- Identifies required RF links between the SS and the DCS ground segment

- Establishes functional and performance requirements related to these links

1.3 Applicable Documents

The following documents of the issue listed, or of the issue in effect on the effective date of contract, form a part of this IRD to the extent specified herein. In the event of conflict between documents specified herein and other detailed content of this IRD, this IRD shall be the superseding requirement.

[1] The Mission Requirements Document 2 (MRD-2B) for the GOES-R Series dated

December 13, 2004

[2] National Geostationary Operational Environmental Satellite Data Collection System Operations Plan, FCM-P28-1997, August 1997

[3] Version 2.0 of the 300/1200 BPS GOES Data Collection Platform Radio Set (DCPRS) CERTIFICATION STANDARDS, NOAA/NESDIS, dated 2004

[4] NOAA/NESDIS Antennas and RF System Capabilities Handbook, NOAA/OSD3-2001-0043R0UD0, 10 August 2001

[5] ITU Recommendation P.531-7 (2003), Ionospheric Propagation Data and Prediction

Methods Required for the Design of Satellite Services and Systems

[6] ITU Recommendation P.581-2 (1990), The Concept of “Worst Month”

[7] ITU Recommendation P.618-8 (2003), Propagation Data and Prediction Methods Required for the Design of Earth-Space Telecommunication Systems

[8] ITU Recommendation P.676-5 (2001), Attenuation by Atmospheric Gases

[9] ITU Recommendation P.679-3 (2001), Propagation Data Required for the Design of Broadcasting-Satellite Systems

[10] ITU Recommendation P.837-4 (2003), Characteristics of Precipitation for Propagation Modeling

[11] ITU Recommendation P.838-2 (2003), Specific Attenuation Model for Rain for Use in Prediction Methods

[12] ITU Recommendation P.839-3 (2001), Rain Height Model for Prediction Methods

[13] ITU Recommendation P.841-3 (2003), Conversion of Annual Statistics to Worst-Month Statistics

[14] NTIA Manual of Regulation and Procedures for Federal Radio Frequency Management, May 2003 Edition, September 2004 Revision

[15] International Telecommunications Union (ITU) Recommendation ITU-R RA 769-1 of the 1998 Edition of the ITU Regulations for Radio Astronomy

[16] ITU Article S21 of the ITU Radio Regulations RR-S21 described in the 2001 Edition of the ITU Regulations for Power Flux Density Limits

Discussion: The ITU documents described in items [5] thru [13] above can be used in determining propagation attenuation. ITU document [5] is for scintillation loss. The dash number used for each document is the updated release number. The web site for the ITU documents is <http://www.itu.int/publibase/catalog/index.asp>

Document [4] contains information about the capabilities of the NOAA Command and Data Acquisition Stations (CDAS).

2.0 DATA COLLECTION SYSTEM (DCS) DESCRIPTION

2.1 General Description

The GOES support to the Data Collection System (DCS) is provided by GOES satellites located at 75º and 135º [TBR] W. Longitude. This system provides bidirectional link connectivity between a large number of outlying Data Collection Platforms (DCP) and the NOAA Command and Data Acquisition Stations (CDAS) and/or Direct Readout Ground Stations (DRGS). These DCPs are typically small remote monitoring stations used for the collection and reporting of near real-time environmental data. These terminals may be located anywhere in the Western hemisphere. DCPs may be located on aircraft, ships, balloons, and fixed sites and collect a wide variety of data (e.g., seismic, water level, wave state, snow and ice cover, etc.). The satellite access methods include either random, scheduled access, or interrogate/report.

Inbound messages from the DCP to the CDAS and/or DRGS, containing the reported data, are called Data Collection Platform Report (DCPR) messages. These are relayed through the GOES-R satellite by a separate DCPR transponder. The user data rates are 300 or 1200 bit/s.

Outbound link connections from the CDAS to a specific DCP, for purposes of initiating a data transfer, are called Data Collection Platform Interrogate (DCPI) messages. In the GOES-R satellite this shared channel is received and transponded in a dedicated DCPI transponder. The user data rate is expected to be 2400 bit/s [TBR].

Although all DCPs must be capable of transmitting DCP messages, only a relatively small fraction of the DCPs are currently capable of receiving and processing DCPI messages. Most rely on scheduled, locally timed, requests to initiate data reporting. The present system characteristics may change during the period when GOES-R becomes operational to include a higher percentage of platforms that include DCPI capability.

Both the DCPR and DCPI transponders are bent-pipe, i.e., receiving the uplinks within a certain frequency band, translating to a new frequency band, amplifying, and retransmitting on the downlink, but with no other processing. For the DCPR link, the uplink is UHF and the downlink is L-Band; for the DCPI link, the uplink is S-Band and the downlink is UHF. In each case, the satellite antenna must provide earth coverage out to a ground station elevation angle of 5º.

The DCPR transmissions are time scheduled channelized frequency division multiple access (FDMA) with a total of up to 433 channels available. The first 400 of these are of 750 Hz bandwidth and are used for 300 bit/s service. Any three adjacent 750 Hz

channels can be combined by NOAA into a 2250 Hz channel for 1200 bit/s service. The remaining 33 channels are of 3 kHz bandwidth and are assigned to the international service. The channel center frequencies are given in [3].

The DCPI transmissions use one of three channels, designated GOES-East, GOES-West, and GOES-Spare.

2.2 Missing Requirements

This document contains all DCS interfaces except those labeled “TBD” and “TBR”. “TBD (To Be Determined) means that the contractor should determine the missing requirement in coordination with the government. The term “TBR” (To Be Reviewed) implies that the requirement is subject to review for appropriateness by the contractor or the government.

2.3 Definitions

The statements in this document are not of equal importance. The word “shall” designates a requirement. Any deviation from the requirements will require approval of the NASA contracting officer.

The word “will” designates a statement of fact about the system, its operational environment or the intent of the government

The word “threshold” is the minimum acceptable performance characteristic.

Rationale: MRD-2B, ID Item 1066

The word “goal” is an optimum level of performance, which, if met, could greatly enhance data utility.

Rationale: MRD-2B, ID Item 1067

3.0 DCPR INTERFACE REQUIREMENTS

3.1 General Requirements

The Data Collection Platforms (DCP’s) provide a UHF transmission capability for the transmission of short data messages (DCPR) through the GOES satellite transponder to the receiving ground stations, either Direct Readout Ground Stations (DRGS) or the CDAS. An optional capability exists at the DCP’s for the reception of an interrogate message (DCPI) addressed to individual DCP’s from the CDAS via the GOES-R satellite. Only those elements necessary for specifying the SS–to–DCS interface will be addressed here.

The two separate message paths, DCPR and DCPI, will be covered separately.

The data link requirements for the DCPR Subsystem are summarized in Table 3.1-1.

DCPR Uplink Tx	**Requirement**	**Rationale**
EIRP dBm)	Para. 3.2.5	Applicable document [3]
Center Freq. (MHz)	Domestic: 401.900	Heritage spec. from GOES-N,O,P, and

	International: 402.200	MRD-2B, ID Item 4469
Bandwidth (kHz)	Domestic: fc ± 200 International: fc ± 200	Heritage spec. from GOES-N,O,P and MRD-2B, ID Item 4468
Polarization	RHC	Para. 4.1.2.1 of App. Doc. [3]
Axial ratio	≤ 6 dB	NOAA Certification Standard paragraph 4.1.2.1.
Tx Data Rate (bit/s)	300 and 1200	Para. 4.3.1 of App. Doc. [3]
Modulation	8-PSK	Heritage spec. from GOES-N,O,P
Coding	Trellis	
Satellite Rx		
Polarization	RHC	Comm. working group recommendation
Axial Ratio	≤ 1 dB	Comm. working group recommendation
Antenna Coverage	Earth coverage to an antenna elevation angle of 5 degrees	Heritage spec. from GOES-N,O,P and MRD-2B ID, Item 4471
Min. Rx G/T (dB/K)	-14 at edge of coverage	Comm. working group recommendation
Dynamic Range (dBmi)	Below noise to -100	Heritage spec. from GOES-N,O,P
Satellite Tx		
DCPR frequency band (MHz)	1697.300 – 1698.000	MRD-2B, ID Item 4470 and CWG recommendation
Polarization	Linear N-S	Heritage spec. from GOES-N,O,P
Min. cross polarization isolation (dB)	25 [TBR]	
EIRP (dBm)	56 [TBR]	Prelim. measured GOES-N data
Antenna Coverage	Earth coverage to an antenna elevation angle of 5 degrees	MRD-2B ID Item 4472
BER	Para 3.4.6	
Ground Rx		
Polarization	Linear N-S	Heritage spec. from GOES-N,O,P
Ground Rx G/T (dB/K) DRGS CDAS	 15 26	 Comm. working group recommendation Heritage spec. from GOSE-N,O,P
Rx System Loss (dB)	2.3	Heritage spec. from GOES-N,O,P

Table 3.1-1 DCPR Data Link Requirements Summary

3.2 DCPR Uplink Interface Requirements

3.2.1 Frequency Channelization

To allow a guard band between the uplink signals and also because the broad uplink antenna pattern of the DCP's can illuminate both east and west GOES satellites, odd numbered channels (1 to 399) are assigned to the GOES east satellite (75º W) and even numbered channels (2 to 400) are assigned to the GOES west satellite (135º [TBR] W).

Channels 1 to 400 are called “domestic” channels; channels 402 to 466 (even numbered only) are called “international” channels and are shared with other international systems (e.g., METEOSAT, GMS, and Russia). The channel center frequencies are shown in [3].

3.2.2 Long Term Frequency Stability

The combined lifetime frequency stability under all conditions of temperature and power supply variation will be less than ± 100 Hz.

3.2.3 Short-Term Frequency Stability

The short-term frequency stability is specified as ± 1 Hz/s under any combination of power supply variation (± 15%) or temperature (-40 C to +50 C).

Rationale: Applicable document [3].

3.2.4 Phase Noise Requirement

The phase noise specification for the 300/1200 bit/s service is < 2.5ºRMS.

Rationale: The phase noise specification is given in [3].

3.2.5 Effective Isotropic Radiated Power (EIRP)

The EIRP is specified for any combination of power supply voltage and temperature variation as follows:

Data Rate (bit/s)	Minimum EIRP (dBm)	Maximum EIRP (dBm)
300	48	50
1200	51	53

Rationale: Paragraph 4.1.1 of applicable document [3].

3.3 Satellite Receive DCPR Interface Requirements

3.3.1 General Requirements

The space segment for the Data Collection System shall be compatible with 89,000 data collection platforms (Threshold), with a goal of 158,000 supported platforms.

Rationale: The requirement described above was provided by ID item 6353 in the MRD-2B document.

3.4 DCPR Satellite Transmit Interface Requirements

3.4.1 Link Performance Requirement

Based on the assumed link parameters of Section 3.4.2, the link performance shall meet the performance criteria for the end-to-end BER (Table 3.1-1) and Section 3.4.3 (Link Availability). Performance is specified for the combined up and downlinks, i.e., for the full path between DCP’s and the DRGS/CDAS.

3.4.2 Assumed Link Parameters

The following conditions shall be assumed in the calculation of expected link performance.

1. The distribution of DCP EIRP values and data rates present at the satellite input is [TBD].

   Discussion: Defining a traffic model is [TBD].

2. Propagation impairments due to atmospheric absorption and rain of 0.2 dB for the UHF links and 0.5 dB for the L-Band links shall be assumed.

3. Scintillation losses do not need to be taken into account. Any location that experiences scintillation needs to take this into account in the specification of that location's terminal characteristics.

4. Elevation angles at both the DCP and the DRGS/CDAS shall be assumed to be the worst case value of 5º.

5. Worst case polarization mismatches on the uplink shall be assumed. For the downlink linear polarization, a 20º mismatch shall be assumed.

6. Interference: Co-channel interference for the DCPR links shall be assumed small and no specific entry is required. The con-channel and adjacent channel interference shall be measured by the s/c contractor and included in the contractor's link budget.

6. A transponder NPR of 20 dB [TBR] shall be provided.

Discussion: The NPR operating point is related to drive back-off for the final amplifier. The output power back-off has to be taken into account when calculating the link performance.

7. An end of life margin of 1 dB shall be assumed.

8. There has to be an AGC circuit in the satellite DCPR channel as the input signal level change is a significant factor in link performance.

3.4.3 Link Availability

The DCPR link calculations shall demonstrate link closure, i.e., positive link margin, under the assumptions specified in Section 3.4.2, with a link availability of 99.9%. This shall be shown using procedures outlined in the ITU references [6 -14].

Rationale: The system requires 24 hours per day, seven days per week (24/7) availability.

3.4.4 Radio Astronomy Band Protection

The DCPR and DCPI downlink EIRP values shall protect the radio astronomy band from 1660 to 1670 MHz, so that the spectral power flux density in this band at the surface of the earth shall be ≤ -266 dB W/m^2-Hz.

Rationale: Compliance is required with the power flux density requirement for the Radio Astronomy Band as described in the International Telecommunications Union (ITU)

Recommendation ITU-R RA 769-1. The ITU specifies a maximum Power flux Density (PFD) at the ground of -251 dBW/m^2/Hz for the RA band, and this level must be reduced by another 15 dB for geostationary satellites.

3.4.5 Power Flux Density Limits

The downlink EIRP for the DCPR and DCPI links shall conform to the ITU regulations Section RRS21, Table S21-4 regarding Power Flux Density (PFD) at the surface of the Earth. The communication links shall comply for both the 1.5 MHz and 4 kHz bandwidths at L-Band.

The spacecraft contractor shall notify GSFC if he determines that any transmission channel requires a higher than allowed EIRP to meet the communications data link performance requirements.

The PFD values for each data transmission service shall be defined by the spacecraft contractor and incorporated into the Interface Control Document (ICD) following the Preliminary Design Review and after approval by GSFC.

Rationale: The ITU regulations are described in Article S21 titled “Terrestrial and Space Services Sharing Frequency Bands above 1 GHz” of the ITU Radio Regulations RR-S21.

3.4.6 End-to-End BER

The threshold BER requirement is 1· 10-6 at 99.9 % availability for the worst month (TBR), and the goal requirement is 1 · 10-7 at 99.9 % availability for the worst month (TBR).

An Eb/No of 11.0 dB for the 300 bps and 1200 bps data links is required for a BER of 1 ·10-6. Any degradation caused by the satellite link shall be included in the link budget as a separate item

Rationale: ID item 4467 in MRD-2B.

3.4.7 Unwanted Radiation Mask

All communication links must comply with paragraph 5.2.2 for frequencies less than 470 MHz and 5.6.2 for frequencies above 470 MHz, of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management, May 2003 Edition, September 2004 Revision.

3.5 Communications Link Budget Requirement

The spacecraft contractor shall provide the communication link budgets in the ICD for the DCPR subsystem.

Changes to the link budget shall be documented and reported monthly to the GSFC Communications Subsystem Manager.

Rationale: There is a need to ensure adequate link margins prior to and following the manufacturing of flight hardware

4.0 DCPI RF INTERFACE REQUIREMENTS

4.1 General Requirements

The data link interface requirements for the DCPI Subsystem are summarized in Table 4.1-1. The DCPI data link shall be supported by primary and redundant bent pipe transponders that do not re-modulate the DCPI uplink transmission.

CDA Uplink Tx	**Requirement**	**Rationale**
EIRP (dBm)	[TBD]	
Freq. (MHz)	GOES-East: 2034.8375 GOES-West: 2034.8250 Spare: 2034.8125	CWG recommendation and MRD-2B ID Item 4482
Polarization	Linear N-S	Heritage spec. from GOES-N,O,P
Tx Data Rate (bit/s)	2400	MRD-2B ID Item 4477
Modulation	BPSK	
FEC	Para. 4.2.1	MRD change request needed
RF Bandwidth	100 kHz minimum (TBR)	MRD-2B, ID Item 4481
Satellite Rx		
Polarization	Linear N-S	Heritage spec. from GOES-N,O,P
Cross polarization isolation (dB)	[TBD]	Comm. working group
Antenna Coverage	Earth coverage to an antenna elevation angle of 5 degrees.	MRD-2B, ID Item 4484
Min. Rx G/T (dB/K)	-15 at edge of coverage	
Nominal rec'd sig. level [dB]	[TBD]	
Dynamic Range (dB)	Nominal level ± 5	
Satellite Tx		
Frequency (MHz)	GOES-East 468.8375 GOES-West 468.8250 Spare 468.8125	MRD-2B ID Item 4483 and CWG recommendation
Polarization	RHCP	
Axial ratio	≤ 1 dB	
EIRP (dBm)	43 [TBR]	Comm. working group recommendation
Antenna Coverage	Earth coverage to an antenna elevation angle of 5 degrees	MRD-2B, ID Item 4485
FER	Para. 4.5	
Ground Rx		
Polarization	RHCP	
Polarization isolation (dB) DRGS CDAS	 25 [TBR] 30 [TBR]	
Min. Rx G/T (dB/K)	-20	Comm. working group recommendation
Rx System Loss (dB)	2.0	Heritage spec. from GOES-N,O,P

Table 4.1-1 DCPI Data Link Requirements Summary

4.2 CDAS Uplink Requirements

4.2.1 Forward Error Correction Coding

The data encoding on the DCPI channel will be a concatenated Convolutional Code, Rate-1/2 with constraint length 7, and a Reed-Solomon block code (255,223) with interleaving depth of 4.

Rationale: To be compatible with the existing user equipment.

4.3 Satellite Transmit Interface Requirements

4.3.1 Radio Astronomy Band Protection

The Radio Astronomy Band Protection requirement for the DCPI service is described in paragraph 3.4.4.

4.3.2 Power Flux Density Limits

The Power Flux Density requirement for the DCPI service is described in paragraph 3.4.5.

4.3.3 Link Availability

The DCPI link calculations shall demonstrate link closure, i.e., positive link margin, under the assumptions specified in Section 4.3.5, with a link availability of 99.9%. This shall be shown using procedures outlined in the ITU references [6 -14].

Rationale: The system requires 24 hours per day, seven days per week (24/7) availability.

4.3.4 Unwanted Radiation Mask

The Unwanted Radiation Mask requirement for the DCPI service is described in paragraph 3.4.7.

4.3.5 Assumed Link Parameters

The following conditions shall be assumed in the calculations of the expected link performance.

1. Propagation impairments due to atmospheric absorption and rain of 0.2 dB for the UHF links and 0.5 dB for the L-Band link shall be assumed.

2. Scintillation losses do not need to be taken into account. Any location that experiences scintillation needs to take this into account in the specification of that location's terminal characteristics.

3. Worst case polarization mismatches on the uplink shall be assumed. For the downlink linear polarization, a 20º mismatch should be assumed.

4. Interference: Interference for the DCPI links shall be assumed small and no specific entry is required.

5. An end of life margin of 1 dB shall be assumed.

6. Elevation angles at both the DCPI and CDAS locations shall be assumed to be the worst case value of 5º.

4.4 Communications Link Budget Requirement

The spacecraft contractor shall provide the communication link budgets in the ICD for the DCPI subsystem.

Changes to the link budget shall be documented and reported monthly to the GSFC Communications Subsystem Manager.

Rationale: There is a need to ensure adequate link margins prior to and following the manufacturing of flight hardware.

4.5 Frame Error Rate Requirement

The required Eb/No at the DCPI receiver shall be 5.6 dB [TBR] for a Frame Error Rate (FER) of 1 X 10^{-5} or better.

Appendix A – Abbreviations and Acronyms

ALC	Automatic Level Control
AM	Amplitude Modulation
AS	Archive Segment
β	Modulation Index
BCH	Bose-Chaudhuri-Hocquenghem (Forward Error Correction Code)
BER	Bit Error Rate
BiΦ-L	Bi-Phase Level
BPSK	Binary Phase Shift Keying
BW	Bandwidth or Beamwidth (context dependent)
C3S	Command, Control and Communications Segment
CDA	Command and Data Acquisition
CDAS	Command and Data Acquisition Station
CCSDS	Consultative Committee on Space Data Systems
C/N_0	Carrier to Noise Density Ratio (dB-Hz)
COSPAS	(Russian: Cosmicheskaya Sistyema Poiska Avariynich Sudov) Space System for the Search of Vessels in Distress
CP	Circularly Polarized or Circular Polarization
DCP	Data Collection Platform
DCPI	Data Collection Platform Interrogate
DCPR	Data Collection Platform Report
DCS	Data Collection System

DRGS	Direct Readout Ground Station
EESS	Earth Exploration Satellite Service
EIRP	Effective Isotropically Radiated Power
ELT	Emergency Locator Transmitter
EMWIN	Emergency Managers Weather Information Network
EPIRB	Emergency Position Indicating Radio Beacons
FDMA	Frequency Division Multiple Access
FER	Frame Error Rate
GEOLUT	Geostationary Local User Terminal
GMS	Geostationary Meteorological Satellite
GOES	Geostationary Operational Environmental Satellite
GRB-F	GOES Rebroadcast - Full
GRB-L	GOES Rebroadcast - Lite
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
G/T	Gain-to-Noise Temperature Ratio (dB/K)
ICD	Interface Control Document
IRD	Interface Requirements Document
ITU	International Telecommunications Union
L-Band	1.5 – 1.6 GHz Frequency Band
LDPC	Low Density Parity Check
LEO	Low Earth Orbit
LHCP	Left Hand Circularly Polarized
LP	Linearly Polarized or Linear Polarization
LRIT	Low Rate Information Transmission
LSS	Launch Support Segment
LUT	Local User Terminal
METEOSAT	Meteorological Satellite
MCC	Cospas-Sarsat Mission Control Center
NASA	National Aeronautics and Space Administration
NOAA	National Oceanographic and Atmospheric Administration
PDR	Preliminary Design Review
PFD	Power Flux Density
PGDS	Product Generation and Distribution Segment
PLB	Personal Locator Beacon
PM	Phase Modulation
ppm	Parts per million

PSK	Phase Shift Keying
RA	Radio Astronomy
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
RMS	Root Mean Square
RR	Radio Regulation
RVTM	Requirements Verification Traceability Matrix
SAR	Search and Rescue
SARSAT	Search and Rescue Satellite-Aided Tracking
S-Band	2.5 – 2.7 GHz Frequency Band
SIS	Solar Imaging Suite
SEISS	Space Environment In-Situ Suite
SS	Space Segment
TBD	To Be Determined
TBR	To Be Reviewed
TBS	To Be Supplied
TRD	Technical Requirements Document
UHF	300 – 3000 MHz Frequency Band (Generally taken to be below 1000 MHz)
UIS	User Interface Segment
USG	United States Government
X-Band	7.25 – 8.4 GHZ Frequency Band